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Notes and Sources

The Luigi Cremona Archive of the Mazzini Institute of Genoa ☆

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Abstract

Luigi Cremona (1830–1903) is unanimously considered to be the man who laid the foundations of the prestigious Italian school of Algebraic Geometry. In this paper we draw attention to the "Legato Itala Cremona Cozzolino", which was given to the library of the Mazzini Institute, Genoa, Italy, by Cremona's daughter, Itala, probably in 1939. This legacy, which contains over 6000 documents, mainly consisting of Cremona's correspondence with scientific and institutional Italian interlocutors, can help us to understand the connections between the development of Italian mathematics in the second half of the XIX century and the main political issues of Italian history.

Sunto

Luigi Cremona (1830–1903) è universalmente riconosciuto come colui che ha dato avvio alla costruzione della scuola italiana di Geometria algebrica.

In questo articolo portiamo all'attenzione degli storici della Matematica il "Legato Itala Cremona Cozzolino", affidato all'Istituto Mazziniano di Genova da Itala, una delle sue figlie.

Non solo la corrispondenza – soprattutto con interlocutori scientifici e istituzionali italiani – che vi è contenuta, ma la storia stessa del Legato sembrano offrire nuovi elementi di comprensione del ruolo giocato dalla comunità matematica nella costruzione dello Stato italiano dopo l'Unità.

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"The life stories of mathematicians are often fascinating human dramas, which show the enormous influence that social circumstances have on the development of mathematics." [Kleiman, 1998, p. 10] The above statement, which expresses the opinion of Steven Kleiman, one of today's leading algebraic geometers, is particularly pertinent to the case of Luigi Cremona whose life story was full of events, political as well as mathematical. In this short paper we want to draw attention to a large but little known archive which contains the correspondence between Cremona and many well-known Italian mathematicians.

Nowadays, Luigi Cremona is unanimously considered to be the man who laid the foundations for the prestigious Italian School of Algebraic Geometry. Kleiman calls him "the father of Italian Algebraic Geometry" [Kleiman, 1998, p. 9]. Cremona's work on the classification of general algebraic curves, cubic surfaces and especially, birational (Cremona) transformations is of the greatest importance for the development of modern Algebraic Geometry, and is tightly inter-related with works by Max Nöther, Rudolf Clebsch and the German school. Some of his students (especially Eugenio Bertini and Giuseppe Veronese), continued his work and made fundamental contributions to this field of research.

As a member of the Italian Senate for 25 years from 1879, Cremona masterminded the main political initiatives towards the development of scientific culture in Italy, and due to his interventions considerable advances were made in the national organization of science during this period.

For each of these reasons – academic and political – the availability of a huge quantity of Cremona's letters and manuscripts is extremely valuable for the history of mathematics.

A large number of documents are in the library of the Mathematics Department "Guido Castelnuovo" of the University of Rome and these have already been studied[1] by Giorgio Israel and Laura Nurzia [Israel and Nurzia, 1983; Nurzia, 1984], and many volumes of correspondence have been published by Israel.[2] This archive contains the majority of the letters to Cremona from foreign mathematicians. Among the letters from German speaking correspondents, are those from Clebsch (28), who was possibly Cremona's keenest scientific interlocutor, from Klein (19) and from Lie (14). From English mathematicians, there are letters from Hirst (30)[3] and from Cayley (22). Hirst was probably Cremona's most affectionate friend and their correspondence covers family and personal affairs as well as mathematical problems.

In their description of the Cremona papers, Israel and Nurzia noted that "other letters probably exist, but we have found no trace of them" [1983, p. 94]. We have found further

[1] The Archive of the Mazzini Institute in Genoa (from now on cited as IMG) holds the original "Verbale di Consegna" (dated March 27, 1912), with the reference number Sc. 56, 14487–14490, by which Cremona's heirs bequeathed Cremona's papers (mainly letters) to the "Scuola di Applicazione per gli Ingegneri" in Rome. From this document we know that the first examination of the works contained in Cremona's office was made on October 25, 1904. As Israel and Nurzia say, these papers "were almost certainly transferred to the library of the present Istituto Matematico" [p. 94]. From the extant documents it is clear that among the manuscripts there were many other papers concerning Cremona's research. As far as we are aware, these papers have not yet been found, either in the mathematics department, or in the Mazziniano. We believe that through a precise reconstruction of the movements of Cremona's papers it should be possible to find other lost papers, if indeed any exist.

[2] See Appendix, part 6.

[3] There are 86 more in the IMG.

documents relating to Cremona in the library of the Mazzini Institute in Genoa which make us certain that the majority of letters to Cremona are now at the disposal of historians of mathematics.[4] The library of the Mazzini Institute specialises in the history of the Italian Risorgimento and Cremona's correspondence is part of the "Legato Itala Cremona Cozzolino" (LICC) given to the library by Itala, his daughter, probably in 1939.[5] As well as Cremona's papers, the bequest includes many important documents about the life of Giuseppe Mazzini, one of the most important political characters during the Italian Risorgimento, and it also contains many of Mazzini's letters.

One may ask why such an extensive mathematical correspondence is kept in such an unlikely place. To answer this question we need to examine the history of the legacy. This will not only throw light on the important role that the Italian mathematical community played during the Risorgimento but will also touch on the main political issues of Italian history. In order fully to comprehend this history, it is helpful to interweave it with a short biography of Luigi Cremona.

Luigi Cremona was born in Pavia, a university town near Milan, in 1830, the son of Gaudenzio and Teresa Andreoli, who were respectively 60 and 20 years old. He had many brothers and sisters. The oldest brother was Giuseppe, who was born in 1796 to Gaudenzio's first wife. The youngest was Tranquillo (1837–1878), a distinguished painter and an important representative of the Italian "Scapigliatura", an innovative movement in figurative arts and in literature.

His sister Giovanna (who was 30 years older than Luigi) was married in Gropello (now called Gropello Cairoli) a little town near Pavia, and it was there that Luigi met the Cairoli family, one of the most important in the history of the Risorgimento. The young Cremona, who was very impressed by the patriotic atmosphere in Pavia and Gropello, became close friends with three of the Cairoli brothers, Luigi, Enrico and Benedetto.

Luigi (1838–1860), a student of mathematics with Brioschi, died of typhoid fever contracted during Garibaldi's famous Expedition of the Thousand (*Spedizione dei Mille*); Enrico (1840–1867) died in the battle of Villa Glori, where Garibaldi was defeated by the Pope's troops and his French allies while trying to conquer Rome; and Benedetto (1825–1889), a close follower of Garibaldi, became an important left wing politician in the Italian Parliament. Benedetto was also a Minister in the Italian government and Prime Minister in 1878 and again from 1879 to 1881. He and Cremona were close friends throughout their lives.

At the beginning of 1848 in Italy, as in many other countries of Europe, there was a revolution in support of democracy and national independence. On January 9th, students in Pavia engaged in urban guerrilla warfare against the Austrian police. Between March 18th and 23rd, Milan rose up and shook off the Austrian yoke. In the meantime, Venice also rose up and the Austrian troops left the city. On April 12th, Neapolitan troops heading to defend Venice, passed through Pavia. Cremona, who was then 17 years old, decided to join the troops and wrote to his mother: "If I had refused to give my life for my country

[4] There are also 33 letters from Cremona to Benedetto Cairoli, his mother Adelaide, and his wife Elena in the Biblioteca Civica "Carlo Bonetta", Archivio Storico Civico di Pavia.

[5] The Archive of the *Mazzini Institute* contains no trace of the official papers describing Itala Cremona Cozzolino's legacy. Prof. Leo Morabito and Ms. Raffaella Ponte, Museum Directors, undertook an extensive search but found nothing significant.

I wouldn't have done my duty and I would have proved to be cowardly and worthless."[6] [Veronese, 1903, p. 664]

During the long siege of Venice (which finally ended with the capitulation of the city on 24th August 1849), Cremona became close friends with a young man from Genoa, Nicolao Ferrari (1827–1855), one of the aides of Giuseppe Mazzini, who was the leader of the Italian republicans. The two men met in Venice in March 1849 and their first meeting is described in an unpublished letter by Nicolao to his mother in IMG.[7]

After the war Cremona returned to Pavia where he studied at the local University under the supervision of Francesco Brioschi, taking his degree in Mathematics in 1853. On August 3rd, 1854 he married Nicolao's sister, Elisa Ferrari (1826–1882), who at that time was the headmistress of the main kindergarten in Genoa, and in touch with Maria Mazzini, Giuseppe's mother. While working hard on mathematics and writing his first papers (1855), Luigi (with Elisa) continued to be in close contact with the revolutionary milieu of Mazzini's supporters, through both Nicolao and Elisa's uncle, Napoleone Ferrari (1802–1882), who was one of Mazzini's aides and, importantly, the family doctor of Mazzini's mother. When Maria died in 1852, Napoleone was the executor of her will and, as Itala Cremona described:

> among further duties, she commissioned him to take care of this collection of letters, (after she had passed away), that she had kept with loving care and had hidden in a secretaire in her room: she didn't want those holy relics to be touched by sacrilegious hands. ... The collection of letters was left to Napoleone Ferrari.[8]

After Napoleone's death in 1882, the correspondence passed on to his son Nicolò, and then to his grandson Giuseppe who, finally, handed it over to Luigi Cremona. Thus when Luigi died, in 1903, the last of Mazzini's letters to his mother (1851–1852) and many other important papers concerning the political life of Italy in the first half of the XIX century were in the hands of Luigi's daughter, Itala, who bequeathed them (together with letters, official reports and other documents relating to the activity of her father) to the IMG.

Returning to the lives of Luigi and Elisa Cremona. In 1855 Elisa's brother Nicolao died. Acknowledging the role that Nicolao had played in his political organization, Mazzini wrote a famous letter (commonly referred to as "sull'immortalità dell'anima", "about the soul's immortality") to Elisa.[9] In this letter, which is in the Archive of the IMG,[10] he writes

[6] Avrei creduto mancare ai dettami della più santa delle religioni e di commettere un atto di viltà e di inettitudine ricusando di dare il sangue per la patria.

[7] IMG, LICC, Sc. 54, 12744.

[8] Fra gli altri obblighi che gli commise vi fu quello di ritirare, appena fosse spirata, questo carteggio che riunito, teneva gelosamente nascosto in un sécretaire posto nella sua camera: non voleva che mano sacrilega osasse toccare queste per lei sante reliquie. ... Il carteggio rimase nella mani di Napoleone Ferrari. [Cremona Cozzolino, 1939, p. III]

[9] This very long letter had been written from London on August 29th, 1855. It was printed in the revolutionary journal *L'Italia del Popolo* on September 6th, 1855 (certainly with Cremona's and Elisa's agreement, but with the omission of Elisa's name – it could be very dangerous for a young man, who lived in the Austrian Empire and had recently participated to the war of 1848, to show such tight links with Mazzini!). Later it was reprinted many times (the last time in 2009) and it appears in almost every Italian anthology devoted to the works of Mazzini dealing with moral and patriotic issues. In 1882, when Elisa died, Cremona managed to have a reprint of the letter (edited by his cousin Acquarone) to send to his closest friends as an obituary for his wife.

[10] IMG, LICC, Sc. 55, 13526.

"I write to you as to a sister, to console you while lamenting and talking about him. I don't believe in death. I believe in life."[11]

In November 1860 Cremona became Professor of Advanced Geometry in Bologna. He considered his growing engagement in scientific research as the way to make his patriotic contribution to the development of Italy. In his opening lecture he blended scientific problems, such as the use of the transformations in Geometry, with patriotic proclamations, in a fascinating way. He both outlined his very modern course in Advanced Geometry:

> the general theory of geometrical transformations, of which homography and correlation are two easy examples; the general theory of plane curves and in particular, the third order ones; the property of double curvature lines and third order surfaces; and so on.[12]

and made plain his attachment to Garibaldi and Italian unification:

> However, once again, I tell you, young people: it is not the vile inactivity that drains body and soul, but military and scientific studies that will help you to contribute to the greatness of our own Italy, which before an astonished Europe is about to once again become part of the association of powerful and free nations, with a single capital, ROME, with a single king, VITTORIO EMANUELE, with a single and great hero, GARIBALDI.[13]

Cremona stayed in Bologna until 1866. During this, his most fruitful scientific period, he worked intensively using the methods of pure geometry to solve problems concerning algebraic surfaces (mostly surfaces of third degree), space curves of third order, and birational transformations (also now called Cremona transformations). A description of this part of Cremona's work was given by Castelnuovo:

> Reconsidering the questions from their beginning, he rebuilds projective geometry and elevates it to a science, by perfecting its research methods and blending geometric intuition with various fundamental results taken from algebra, in a most skilful way. He knew how to use these methods in such an expert way that the new algebra could find answers which classical algebra, weighed down by the baggage of formulas, was only able to find with great effort.[14]

While he was in Bologna, Cremona was deeply engaged in research activities and published many papers. These papers include two long essays, one presenting the first systematic exposition of the theory of algebraic plane curves (taught in his course in Advanced Geometry) [Cremona, 1861b], and the other on the theory of algebraic surfaces in ordinary

[11] Vi scrivo come a sorella, a darvi, lamentando insieme e parlando di lui quel conforto che per me si può. Io non credo nella morte. Credo nella Vita. [Cremona Cozzolino, 1939, p. 349]

[12] La teoria generale delle trasformazioni geometriche, delle quali l'omografia e la correlazione sono due semplici esempi; la teoria generale delle curve piane ed in ispecie di quelle del terz'ordine; le proprietà delle linee a doppia curvatura e delle superficie di terz'ordine; ecc. [Cremona, 1861a]

[13] Ancora una volta dunque, o giovani, io vi dico: non la turpe inerzia che sfibra anima e corpo, ma i militari e li scientifici studi vi faranno ajutatori alla grandezza di questa nostra Italia, che sta per rientrare, al cospetto dell'attonita Europa, nel consorzio delle potenti e libere nazioni, con una sola capitale, ROMA, con un solo re, VITTORIO EMANUELE, con un solo e massimo eroe, GARIBALDI. [Cremona, 1861a]

[14] Riprendendo le questioni dall'origine rifonda la geometria proiettiva e la eleva a scienza, perfezionandone i procedimenti di indagine e fondendo nel modo più abile la intuizione geometrica con alcuni risultati fondamentali tolti dall'algebra. E questi procedimenti seppe adoperare con tale sagacia da permettere alla nuova algebra risposte che l'algebra classica, appesantita dal bagaglio delle formule, solo con fatica riuscì a trovare. [Castelnuovo, 1930, pp. 613–614]

spaces [Cremona, 1867]. But his fundamental contribution of this period was the introduction of birational transformations which generalized the notion of projective transformations and quadratic transformations [Cremona, 1863]. His stay in Bologna ended with one of his major achievements: his paper on cubic surfaces that in 1866 was awarded the Steiner prize (shared with R. Sturm) [Cremona, 1868].[15]

It was also during his time in Bologna that Cremona became acquainted with a large number of Italian and European mathematicians. The Archive of the IMG contains many new documents about the early stages of these contacts and their subsequent development. Cremona's correspondence with the Italian mathematicians (e.g. Eugenio Beltrami,[16] Enrico Betti, Francesco Brioschi, Felice Casorati, Placido Tardy ...) is of particular importance, not only because of the clear description of the Italian academic life and its problems, but also because of the discussions concerning two of the main organizational problems of the Italian scientific world: the problem of the development of the main Italian mathematical journal (*Gli Annali*), and the didactical problems relating to the programs and content of mathematical learning and teaching. The Archive of the IMG contains a large number of letters which shed light on these historical questions. Another important issue, strictly linked to the didactical problems (mainly at university level), is the training of a new ruling group in Italy, a group no longer composed mostly of lawyers with a humanistic education, but one composed of engineers and technicians with sound scientific knowledge. The role played by Brioschi, Cremona, and many of the Italian mathematicians in this respect cannot be overstated.

In 1866 Cremona went from Bologna to Milan, to the newly set up Polytechnic school, directed by his former teacher, Francesco Brioschi. He stayed there until 1873 when he moved to establish the new Faculty of Engineering in Rome, where he remained until his death in 1903.

The years that Cremona spent in Milan were also highly fruitful from a scientific point of view. Cremona was then teaching to students of engineering and, as he wanted to interconnect his didactical needs with his research programs, he partially shifted towards applied mathematics, especially Graphical Statics, to which he made important contributions. Among others, we cite two important books [Cremona, 1872, 1874].

In the Archive of the IMG there are many letters of this period, mainly the ones to and from Beltrami. From the point of view of research in pure mathematics, we emphasise Cremona's efforts to keep pace with the rapidly changing face of modern mathematics. In particular, he tried hard fully to understand Riemann's theory, and to translate it into a more geometric language. For example, in 1865, just prior to his move to Milan, he had already written to Tardy:

> I want to learn Riemann's theory, too; for this purpose I have decided to wait, either for the publication of Clebsch's work, or the publication of the lectures, which Casorati, (who succeeded in penetrating and getting to the bottom of that theory,) will hold this year in Pavia.[17]

[15] On this paper we refer to Dolgachev [2005]; important hints on modern appreciation of the mathematical work of Cremona and his school are also in Kleiman [1998].

[16] There are more than one thousand letters to and from Beltrami in the Archive of Genoa.

[17] Anch'io ho voglia di conoscere la teoria di Riemann; ma a tal uopo sono deciso di aspettare o la pubblicazione d'un lavoro del Clebsch ... o la pubblicazione delle lezioni che farà in quest'anno a Pavia ... il Casorati, il quale è riuscito a penetrare e a veder chiaro ne' misteri di quella teoria [Cerroni and Fenaroli, 2007, p. 103]. The work of Clebsch referred to in Cvemona's letter is in Clebsch and Gordan [1866].

In later correspondence (mainly with Beltrami, Betti and Tardy) we find many other useful references to these efforts which gave rise to the celebrated lectures of Brioschi, Casorati and Cremona on elliptic functions in 1868 (respectively in Jacobi – i.e. algebraic – Riemann – i.e. topological – and Clebsch – i.e. geometric – style),[18] and to an important book by Casorati on the functions of complex variables [Casorati, 1868].

On September 20th, 1870, Rome was conquered by the Italian troops and became the capital of Italy. The University of Rome was to be transformed into one of the most advanced in Europe, in particular in relation to scientific and technical knowledge, and in 1873 Cremona was called on by the Minister of Education to run the Faculty of Engineering. Cremona regarded his administrative duties as the fulfilment of his patriotism, but the different political and didactical responsibilities made it impossible for him to continue his scientific activity at a high level. It is sufficient to note that he published 147 papers during his life and of those 75 were published before 1867, 27 were published in the 6 years up to 1873, and 45 (of which only 15 are scientific papers) were published in the 30 years prior to his death.

During the Roman period Cremona became one of the best known scholars in Europe. He was a member of most of the principal Academies. Besides running the Faculty of Engineering, he became Senator (and Vice-President of the Senate) in 1879. In 1880 he was appointed director of the greatest library in Italy, the Vittorio Emanuele library in Rome. In 1881 the Prime Minister, Quintino Sella, asked him to become the Minister of Education, but – even though he had been and still was a close friend of Sella, collaborating with him in the organization of the Accademia dei Lincei – he refused because Sella had been appointed as Prime Minister in opposition to his close friend, the sitting incumbent Benedetto Cairoli.[19]

Eventually, many years later, in 1898, Cremona did become Minister of Education (but only for one month[20]) and proposed a reform of the Italian school organization. But he was not in office long enough for the proposal to receive the approval of Parliament.

Cremona deeply felt the difficulties in continuing his scientific work. In 1877 he wanted to go to Pisa where he could work with Enrico Betti. He wrote to his wife:

> You may remember that when the present position in Rome was offered to me, I hesitated before accepting... I foresaw that I would have had to take very hard tasks upon myself, but I could never have imagined such an enormous and total sacrifice. All my time, all my strengths were absorbed by administrative jobs and I couldn't do anything for science, which is where my only ambition lies. ... Therefore it isn't strange that for a long time I have felt bitter regret about having come to Rome and have vaguely desired to leave.[21]

[18] On these lectures see Armenante and Jung [1869].

[19] The draft of this letter is in IMG, LICCI, Sc. 51, 11846.

[20] The year 1898 from a political point of view was a very difficult year for Italy; in May, just before Cremona was appointed Minister, there had been severe clashes between striking workers and soldiers of Italian army in Milan which had resulted in many deaths. The Prime Minister Di Rudinì was obliged to resign in June and Cremona followed the destiny of his government.

[21] Ti ricorderai che quando mi fu offerto l'attuale officio in Roma, io non accettai senza esitazione ... Prevedevo di dovermi sobbarcare a occupazioni assai gravi, ma non mi sarei mai sognato un sacrificio così enorme e completo. Assorbito tutto il mio tempo, tutte le mie forze da lavori amministrativi, non potei più far nulla per la scienza, nella quale è riposta l'unica mia ambizione. ... Non è quindi strano che io già da tempo provassi amaro pentimento d'esser venuto in Roma ed aspirassi vagamente ad uscirne. (IMG, LICC, Sc. 51, 11831).

However, Cremona could never satisfy his great desire to free himself from the bureaucratic and administrative jobs. The pressure he received from close friends, who reminded him of his patriotic duties, is clearly evident in a letter[22] sent to him on October, 4, 1877 by Quintino Sella:

> If you went away, there would be serious consequences from every point of view. I don't know what would remain of the Scuola di Applicazione. I don't know what would remain of the Academy either. It would be such a big mess that if you think about the consequences even for a minute, your wish to leave would completely disappear. If scientists don't want to stay in Rome, if they can't put up with any inconveniences that may arise for the sake of our country, they demonstrate by their behaviour, that in their opinion... horribile dictu... Rome must be given back to the Pope. This is a strong appeal, both to your patriotism, and to your love for science. I perfectly understand that you would much prefer to engage in pure science. But we all have important duties towards our country, in particular, when we have to raise it from the abyss where it has fallen after so many centuries of captivity and corruption. It is not sufficient to have thrown foreigners out of the country and to have reached Rome. It is necessary to have the appropriate capacity to prevent them from returning and to keep the Pope in his Church. For this purpose it is necessary for a large number of strong minds to gather in Rome to uphold the honour of modern sciences.[23]

Cremona remained in Rome and became more and more involved in the political affairs, and was also given new heavier administrative and political duties becoming director of the Vittorio Emanuele library and a member of the Italian Senate. So his contributions to science became less and less. The correspondence in IMG which contains many letters of political content, valuable for the history of the development of the scientific institutions in Italy, reflects the situation. Nevertheless, Cremona did succeed in maintaining close relations with European mathematicians and in using his excellent organizational skills to help with the development of the Italian mathematical school. To quote Castelnuovo once more:

> In order to start a school, neither the qualifications of the founder nor his ability to outline a plan of research that exceeds his own capacity, suffices. It is necessary for him to be able to communicate his passion and faith to his disciples, and that he knows how to

[22] This letter has been published in Quazza and Quazza [1990–2005, V, pp. 550–551].

[23] Se voi ve ne andate, le conseguenze sarebbero gravissime sotto ogni punto di vista. Non so ciò che rimarrebbe della Scuola di applicazione. Non so ciò che rimarrebbe dell'Accademia. Sarebbe uno scompiglio così grave che se pensate anche solo un momento alle conseguenze ogni voglia di andarvene debba scomparire del tutto. Se gli uomini di scienza non vogliono stare a Roma, se non sopportano qualche inconveniente, che vi possa essere in vista delle necessità della patria, essi dichiarano con la loro condotta, che sono d'avviso ... horribile dictu ... che si deve ridare Roma al papa. Io faccio quindi il più caldo appello al vostro patriottismo, ed anche al vostro amore per la scienza. Capisco perfettamente che vi sarebbe infinitamente più gradito il fare della scienza pura. Ma abbiamo tutti dei grandi doveri verso la patria, sovratutto quando si tratta di rialzarla dall'abisso in cui era caduta dopo tanti secoli di servitù e di corruzione. Non basta avere cacciato gli stranieri ed essere giunti a Roma. Bisogna avere la virtù necessaria perché quelli non tornino ed almeno perché il papa stia nella sua chiesa. Per tale scopo è indispensabile che a Roma si raccolga una eletta schiera di forti ingegni che tengano con onore il corso delle scienze moderne. ... Tranquillizzatemi, vi scongiuro, per quanto disse il Coppino a Cannizzaro, poiché non vi nascondo che la vostra determinazione, se fosse di andare a Pisa, riuscirebbe per me uno dei più gravi colpi che avrei avuto in questi ultimi anni. (IMG, LICC, Sc. 56, 14227)

> both demand and direct their collaboration. Luigi Cremona was eminently endowed with these qualities.[24]

Nowadays, we rightly consider Cremona to be the founder of the Italian Algebraic Geometry school, even though the new generation of Italian Geometers (Segre, Castelnuovo, Enriques, Severi) used very different methods.

The project

A great part of the correspondence of the most important mathematicians of the first 30 years after the unity of Italy has been saved. These letters form an impressive corpus which reveals how a small group of young mathematicians were led to create, almost from nothing, a first-class mathematical community in just 20 years (circa 1858–1878), such as to make Darboux state in 1870: "I think that if things continue to go on in this way, Italians will surpass us in a short time."[25]

Through these letters we can follow day by day the human, scientific and political happenings of this community. The line of their researches, their contacts with the European mathematicians, their hopes and goals can all be studied in detail.

In particular, it is possible to investigate thoroughly discussions about:

- the spread in Italy (but also in France) of non-Euclidean geometries, of Riemann's ideas regarding complex analysis and geometry, of different methods in algebraic geometry (Chasles, Steiner, Staudt, Möbius), of the study of algebraic equations, of mathematical physics, etc.;
- the development of the main organizations of Italian research: journals (such as Annali di Matematica, Giornale di Battaglini, Rendiconti del Circolo Matematico di Palermo), scientific societies (Accademia dei Lincei, Circolo Matematico di Palermo), universities (Politecnico di Milano, Università di Roma);
- the politics of scientific research and the teaching of mathematics in Italy.

Over time many Italian researchers have examined important parts of these archives and discussed these matters, but much of their work is still difficult to consult and remains unknown outside Italy. Furthermore, these earlier researches have not been drawn together.

The main goals of our research project (partially supported by the Italian Ministry for Universities and by the Research Centre "matematita") are to develop the study of the archival materials and to coordinate and make available works already published.

In particular, in the short term, we aim to:

- produce a complete census of the correspondence and other handwritten materials relating to Luigi Cremona, stored in Italian and foreign countries' archives. This aim will progressively broaden to include materials regarding the other main protagonists of Italian mathematics during the first 30 years after the unification of Italy, in particular Angelo

[24] Per dar vita ad una scuola non basta il valore del maestro, né basta che egli sappia tracciare un piano di ricerche così vasto da superare la propria forza di lavoro. Occorre altresì che egli riesca a comunicare la sua passione e la sua fede ai discepoli e sappia esigerne e dirigerne la collaborazione. Queste doti possedeva in grado eminente Luigi Cremona. [Castelnuovo, 1930, p. 615]

[25] "Je crois que si cela continue les Italiens nous dépasseront avant peu"; In H. Gispert, 1987. La correspondence de G Darboux avec J. Houel, Cahiers du Séminaire d'histoire des mathématiques, 8, 67–202.

Genocchi, Placido Tardy, Francesco Brioschi, Enrico Betti, Giuseppe Battaglini, Eugenio Beltrami and Felice Casorati;
- completely digitize the Legato Itala Cremona Cozzolino and other materials in the Istituto Mazziniano di Genova;
- create a website where it will be possible to find easily all the published works;
- the publication and study of the main correspondence, starting from the unpublished materials regarding Luigi Cremona.

In the following Appendix we list the most mathematically interesting documents in the *Legato Itala Cremona Cozzolino*, after which we briefly describe, for each of the goals, the extant materials (published or in press in the framework of the project or by other researchers).

Appendix A

1. A short list of Cremona's mathematical correspondence in the Mazzini Institute of Genoa

Federico Amodeo (1859–1946) (44 letters, 1896–1899)
Angelo Armenante (1844–1878) (15 letters, 1870–1876)
Cesare Arzelà (1847–1912) (2 letters, 1879–1881)
Ferdinando Aschieri (1844–1907) (5 letters, 1876–1900)
Giulio Ascoli (1843–1896) (13 letters, 1869–1876)
Giuseppe Battaglini (1826–1894) (149 letters, 1862–1894)
Giusto Bellavitis (1803–1880) (61 letters, 1860–1880)
Eugenio Beltrami (1835–1900) (1029 letters, with many letters of Cremona, 1860–1900)
Eugenio Bertini (1846–1933) (14 letters, 1864–1878)
Enrico Betti (1823–1892) (81 letters, 1865–1887)
James Booth (1806–1878) (4 letters)
Francesco Brioschi (1824–1897) (136 letters, 1855–1889)
Ettore Caporali (1855–1886) (48 letters, 1876–1886)
Felice Casorati (1835–1890) (110 letters, 1860–1886)
Eugen Catalan (1814–1894) (3 letters, 1890–1893)
Arthur Cayley (1821–1895) (4 letters)
Valentino Cerruti (1850–1909) (17 letters, 1874–1888)
Enesto Cesàro (1859–1906) (8 letters, 1886–1889)
Domenico Chelini (1802–1878) (2 letters)
Pasquale Del Pezzo (1859–1936) (1 letter)
Riccardo De Paolis (1854–1892) (1 letter)
Eugène Dewulf (1831–1896) (2 letters)
Ulisse Dini (1845–1918) (12 letters)
Maurice D'Ocagne (1862–1938) (1 letter)
Charles Dodgson (1832–1898) (1 letter)
Francesco D'Ovidio (1843–1933) (24 letters)
Andrea Gabba (3 letters)
Angelo Genocchi (1817–1889) (54 letters)
James Glaisher (1809–1903) (4 letters)
Giovan Battista Guccia (1855–1914) (43 letters)
Charles Hermite (1822–1901) (1 letter)

Thomas Archer Hirst (1830–1892) (86 letters)
Morgan Jenkins (1 letter)
Giuseppe Jung (1845–1926) (47 letters, 1876)
Seligmann Kantor (1857–1902) (8 letters)
Felix Klein (1849–1925) (4 letters)
Leopold Kronecker (1823–1891) (1 letter)
Ernst Eduard Kummer (1810–1893) (1 letter)
Guglielmo Libri (1803–1869) (1 letter)
Sophus Lie (1842–1899) (1 letter)
Jacob Lüroth (1844–1910) (7 letters)
Luigi Menabrea (1809–1896) (7 letters)
Gösta Mittag Leffler (1846–1927) (2 letters)
Amédée Mannheim (1831–1906) (55 letters)
Max Noether (1844–1921) (1 letter)
Emile Picard (1856–1941) (1 letter)
Henri Poincaré (1854–1912) (3 letters)
Giacomo Platner (1833–1897) (34 letters)
Eugène Prouhet (1817–1867) (1 letter)
Theodor Reye (1838–1919) (1 letter)
Raffaello Rubini (1817–1890) (27 letters)
George Salmon (1819–1904) (3 letters)
Achille Sannia (1823–1892) (7 letters)
Ludwig Schläfli (1814–1895) (1 letter)
Henry Smith (1826–1883) (9 letters)
William Spottiswood (1825–1883) (16 letters)
Kyparissos Stephanos (1857–1917) (1 letter)
Rudolf Sturm (1841–1919) (4 letters)
James Sylvester (1814–1897) (1 letter)
Peter Tait (1831–1901) (5 letters)
Placido Tardy (1816–1914) (51 letters)
Nicola Trudi (1811–1884) (3 letters)
Domenico Turazza (1813–1892) (5 letters)
J. Vanecek (7 letters)
Giulio Vivanti (1859–1949) (1 letter)
Emil Weyr (1848–1894) (1 letter)
Gustav Wolff (1834–1913) (20 letters, 1883)
Hieronymus Georg Zeuthen (1839–1920) (1 letter)

2. Archives (other than Department of Mathematics in Rome and the IMG Genoa) containing letters from Cremona:

– *Archivio Betti*, *Scuola Normale Superiore, Pisa*: 126 letters to Enrico Betti.
– *Archivio Casa Carducci, Bologna*: 35 letters to Giosuè Carducci (1866–1898).
– *Archivio dell'Accademia delle Scienze detta dei XL*, *Roma*: 14 letters to Stanislao Cannizzaro.
– *Archivio Generale delle Scuole Pie, Roma, Regestum Letterario – Scientificum 329*: 36 letters to Domenico Chelini.

– *Archivio Sella di San Gerolamo – Biella, Carteggio di Quintino Sella*: 61 letters to Quintino Sella.
– *Archivio Storico Civico di Pavia. Archivio Cairoli*, *cart. XII, n. 408*: 35 letters to Adelaide, Benedetto, and Elena Cairoli and one letter of the minister Genala to Cremona.
– *Biblioteca Universitaria di Genova*, *Cassetta Loria, Genova*: 74 letters to Placido Tardy.
– *Carteggio di Federico Amodeo*, *Università di Salerno*: 11 letters to Federico Amodeo.
– *Fondo Brioschi*, *Politecnico di Milano*: 6 letters to Francesco Brioschi.
– *Fondo Siacci*, *Dipartimento di Matematica e Applicazioni R. Caccioppoli, Napoli*: 71 letters to Angelo Genocchi.
– *Klein's Nachlass, Niedersachsische Stats und Universitätbibliothek Göttingen*: 5 letters to Felix Klein.
– *Institut Mittag-Leffler, Stockholm*: 21 letters to Gösta Mittag-Leffler from Cremona and his relatives.

3. The main Archives containing letters of the others principal Italian mathematicians of the period considered:

– Eugenio Beltrami: there is no Archive devoted to Beltrami, but there are many of his letters in various other archives (for example, as we already said, the letters to and from Cremona are in the *Istituto Mazziniano*, Genova).
– Enrico Betti: in the *Biblioteca Scuola Normale Superiore*, Carte Betti, in Pisa.
– Francesco Brioschi: the Archive of Brioschi is in *Fondo Brioschi*, Facoltà di Ingegneria, Politecnico di Milano.
– Felice Casorati: there is a big Casorati Archive, still owned by one of Casorati's descendants, Prof. Franco Maggi Gabba, on this archive see Neuenschwander [1979].
– Angelo Genocchi: the Archive of Genocchi is mainly in the *Biblioteca Passerini Landi* of Piacenza and partially in *Fondo Siacci*, Dipartimento di Matematica e Applicazioni R. Cacioppoli, in Napoli.
– Placido Tardy: more than 600 letters directed to him are in the *Biblioteca Universitaria di Genova*, Cassetta Loria, Genova.

4. The website www.Luigi-Cremona.it

The aim is to include:

– significant obituaries and studies about the Italian mathematicians of the period under consideration;
– mathematical works (and also other material which could be interesting for the history of mathematics, such as political positions about educational issues) of the scholars studied;
– letters and the other manuscript materials contained in the Archives in a format that can be easily consulted;
– transcriptions of the most important manuscript materials contained in the Archive;
– a complete bibliography on the subject studied;
– links with the most important websites with reference to similar issues.

We shall start by adding to the website some of the material contained in the Istituto Mazziniano, Genova.

5. The digitized material

We have completed the digitization of the material contained in the *Istituto Mazziniano*, Genova (*Legato Itala Cremona Cozzolino*) and in the *Biblioteca Universitaria*, Genova (*Cassetta Loria*, *Carte Tardy*). The *Scuola Normale Superiore*, Pisa is undertaking the complete digitization of its *Fondo Betti*.

6. Volumes of Cremona's correspondence already published:

(i) Volumes published in the framework of the project supported by the Italian Ministry of University (PRIN) and by the Research Centre "matematita":
- C. Cerroni, G. Fenaroli (Eds.), 2007. Il Carteggio Cremona–Tardy (1860–1866), Mimesis, Milano.
- N. Palladino, A.M. Mercurio, F. Palladino (Eds.), 2009. Le corrispondenze epistolari Brioschi–Cremona e Betti-Genocchi, Olschki, Firenze.
- I. Rubini (Ed.), 2007. Nicolao Ferrari: lettere e documenti, Mimesis, Milano.

(ii) Volumes edited under the leadership of Giorgio Israel:
- A. Millán Gasca (Ed.), La corrispondenza di Luigi Cremona (1830–1903), I, Quaderni della Rivista di Storia della Scienza, 1, Roma, 1992.
- M. Menghini (Ed.), La corrispondenza di Luigi Cremona (1830–1903), II, Quaderni della Rivista di Storia della Scienza, 3, Roma, 1994.
- M. Menghini (Ed.), Per l'Archivio della corrispondenza dei Matematici italiani. La corrispondenza di Luigi Cremona (1830–1903), III, Quaderni P.RI.ST.EM. – Università Bocconi, Palermo, 1996.
- L. Nurzia (Ed.), Per l'Archivio della corrispondenza dei Matematici italiani. La corrispondenza di Luigi Cremona (1830–1903), IV, Quaderni P.RI.ST.EM. – Università Bocconi, Palermo, 1999.

(iii) Other published correspondence:
- *L'Epistolario Cremona–Cesàro*: L. Carbone, R. Gatto, F. Palladino (Eds.), 2002. Una comunità e un caso di frontiera. L'epistolario Cremona–Cesaro e i materiali correlati, Memorie dell'Accademia di Scienze M. e F., Liguori, Napoli.
- *L'Epistolario Cremona–Genocchi*: L. Carbone, R. Gatto, F. Palladino (Eds.), 2001, Olschki, Firenze.
- *The correspondence with Ludwig Schläfli*: J.H. Graf, Bollettino di Bibliografia e Storia delle Scienze Matematiche, XIX, 1917, 43–49 and 67–73.
- *Two letters of F. Amodeo and one letter from G. Castelnuovo*: in F. and N. Palladino, 2006. Dalla "moderna geometria" alla "nuova geometria italiana", Olschki, Firenze.
- *One letter to Adelaide Cairoli*: in E. Ghiglione Giulietti, 1960. Adelaide Cairoli e i suoi figli. Lettere inedite dal 1847 al 1871, Cortina, Pavia.
- *One letter to Benedetto Cairoli*: in M. Rosi, I Cairoli, 1908, 2 vol., Bocca, Torino.
- *Four letters to Benedetto Cairoli*: in G. Zaffignani (Ed.), s.d., Carissimo Presidente, Antologia dei corrispondenti di Benedetto Cairoli, E.M.I. Pavia.
- *Many letters from Quintino Sella*: in G. Quazza, M. Quazza (Eds.), 1990–2005, Epistolario di Quintino Sella, Istituto per la Storia del Risorgimento Italiano, I–VII.

7. Volumes in press or in preparation in the framework of the project

(i) Volumes in press (in the order in which we expect them to be published):
- M.R. Enea. Corrispondenza tra Beltrami e Tardy, Mimesis, Milano.
- M.R. Enea, R. Gatto (Eds.), Corrispondenza tra Cremona e Chelini, Mimesis, Milano.
- C. Cerroni, L. Martini (Eds.), La corrispondenza tra E. Betti e P. Tardy, Mimesis, Milano.
- A. Brigaglia, S. Di Sieno (Eds.), La Corrispondenza massonica di Cremona (con G. Carducci e F. Magni), Mimesis, Milano.
- G. Canepa, G. Fenaroli (Eds.), La corrispondenza tra P. Tardy e G. Bellavitis, Mimesis, Milano.

(ii) Volumes in preparation:
- the correspondence with E. Beltrami (3 volumes);
- the letters from E. Betti to Cremona (the letters from Cremona to Betti have already been published by Carbone, Gatto and Palladino in the third volume of Israel's series);
- the correspondence with the Paduan mathematician G. Bellavitis;
- the correspondence with B. Cairoli and other people politically involved.

8. Volumes published on the correspondence of Italian mathematicians of the period:

- U. Bottazzini, 1978. Multiply-periodic functions in the correspondence between Hermite and Casorati, Archive for the History of Exact Sciences, 18, 1978, 39–88.
- L. Boi, L. Giacardi, R. Tazzioli (Eds.), 1998. La découverte de la géométrie non euclidienne sur la pseudosphère. Les lettres de Eugenio Beltrami à Jules Houel (1868–1881), Blanchard, Paris.
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